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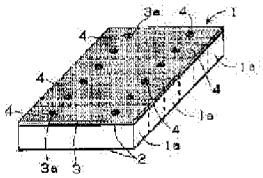
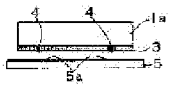
MORITA KATSUHIKO

(54) MANUFACTURE OF PIEZOELECTRIC TRANSDUCER





(57)Abstract:

PROBLEM TO BE SOLVED: To stabilize the characteristics by promoting free vibration by forming a solder bump at the opening part of a piezoelectric element, wherein the opening of a solder resist is located, and coupling a supporting part, which is to become a supporting place at the node of the vibration of the

piezoelectric element, to the supporting electrode of a supporting substrate. SOLUTION: A solder resist 3, which is formed on one main surface of an electrode 2 of a piezoelectric substrate 1, has an opening 3a at the supporting part of a divided each piezoelectric element 1a corresponding to the node of the bending vibration. A solder bump 4 is formed at the opening position of the electrode 2 located at the opening 3a. The piezoelectric substrate 1, wherein the solder bump 4 is formed, is cut and divided intol a plurality of the piezoelectric elements 1a. The node part of the piezoelectric element 1a is limitedly supported by the supporting body, which is formed by the fusion, solidification and deformation of the solder part bump 4. This supporting body imparts the strength for supporting the piezoelectric element 1a and the electric connection to a supporting electrode 5a. From the remaining electrode 2 of the piezoelectric element 1a, a lead wire is guided out at the node point of the vibration.

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* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] The manufacture approach of the piezoelectric transducer which serves as more the process which forms the solder resist which has opening in the supporter of this piezoelectric device in one principal plane of a piezoelectric device in which the electrode was formed, the process which form a pewter bump at least in opening of said electrode located in said opening of said solder resist, the process which attach said piezoelectric device in said support substrate by combining said pewter bump with the support electrode of a support substrate, and the process which remove said solder resist.

[Claim 2] The process which forms the solder resist which has two or more openings arranged at equal intervals in one principal plane of the piezo-electric substrate with which the electrode was formed, The process which divides said piezo-electric substrate into two or more piezoelectric devices which have said opening of said solder resist, The process which forms a pewter bump at least in opening of said electrode located in said opening of said solder resist in said piezoelectric device, and by combining said pewter bump with the support electrode of a support substrate The manufacture approach of the piezoelectric transducer which serves as more a process which attaches said piezoelectric device in said support substrate, and a process which removes said solder resist.

[Claim 3] The process which forms the solder resist which has two or more openings arranged at equal intervals in one principal plane of the piezo-electric substrate with which the electrode was formed, The process which forms a pewter bump at least in opening of said electrode located in said opening of said solder resist in said piezo-electric substrate, The process which divides said piezo-electric substrate into two or more piezoelectric devices which have said pewter bump, and by combining said pewter bump of said piezoelectric device with the support electrode of a support substrate The manufacture approach of the piezoelectric transducer which serves as more a process which attaches said piezoelectric device in said support substrate, and a process which removes said solder resist.

[Claim 4] The process which forms the solder resist which has at least one opening in one principal plane of the support substrate with which the electrode was formed, The process which forms a pewter bump at least in opening of said electrode located in said opening of said solder resist in said support substrate, and by combining the supporter of a piezoelectric device with said pewter bump The manufacture approach of the process which attaches said piezoelectric device in said support substrate, the process which removes said solder resist, and the piezoelectric transducer which becomes more.

[Claim 5] The process which forms the solder resist which has two or more openings in one principal plane of the piezo-electric substrate with which the electrode was formed, The process which forms a pewter bump at least in opening of said electrode located in said opening of said solder resist in said piezo-electric substrate, By combining said pewter bump of said piezo-electric substrate with this support electrode of an insulating substrate with which two or more support electrodes were formed The manufacture approach of the piezoelectric transducer which serves as more a process which attaches said piezo-electric substrate in said insulating substrate, a process which divides the combination of said piezo-electric substrate and insulating substrate into two or more piezoelectric transducers, and a process which removes said solder resist.

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the manufacture approach of the piezoelectric transducer used for an oscillating gyroscope, a radiator, a resonator, a filter, etc.

[0002]

[Description of the Prior Art] The manufacture approach of the conventional piezoelectric transducer is explained with reference to drawing 17 from drawing 13 . First, in drawing 13 , 50 is a rectangular parallelepiped-like piezoelectric device and the electrode 51 is formed in the both sides which counter, respectively. Although this piezoelectric device 50 has various oscillation modes, it serves as a part which the node 52 of the crookedness oscillation mode shows with a broken line. On the other hand, 53 is a support substrate. It faces attaching a piezoelectric device 50 in the support substrate 53, and it is necessary to support by the node 52 of a piezoelectric device 50 so that crookedness vibration of a piezoelectric device 50 may not be oppressed.

[0003] As the manufacture approach of this base material, conventionally, the

piezoelectric device 50 to which conductivity or the pewter paste 54 was applied to the part of the node 52 of a piezoelectric device 50, and this paste 54 was applied by the dispenser or the printing machine is laid on the support substrate 53, as shown in drawing 14 , and a paste 54 is contacted on support electrode 53a formed in the support substrate 53. And applied proper thrust to the piezoelectric device 50, the paste 54 was hardened or melting solidified, and the piezoelectric device 50 was made to fix to the support substrate 53.

[0004]

[Problem(s) to be Solved by the Invention] However, in the manufacture approach of the conventional piezoelectric transducer, since the paste 54 was applied with the dispenser or the printing machine, dispersion and spreading area were changing [coverage] with viscosity change of a paste 54 or change of work environment in with time and continuous operation. Therefore, a piezoelectric device 50 was not supported by the proper part of the node 52, but the property of a piezoelectric transducer varied. Therefore, in order to hold coverage uniformly, work environments, such as viscosity of a paste 54 and temperature, needed to be managed uniformly, and the degradation of an activity was caused.

[0005] Moreover, there was a problem that rotated horizontally and it was fixed as incline in a longitudinal direction, and it is fixed, and a piezoelectric device 50 shows [as opposed to / when a paste 55 fuses, as it is shown in drawing 15 / the support substrate 53] drawing 16 , and incline in the direction of a short hand, and it is fixed and it is shown in drawing 17 . Especially, in the case of the piezoelectric device 50 for oscillating gyroscopes, whenever [fixed angle / of the piezoelectric device 50 to the support substrate 53], and inclination precision were important, and since this piezoelectric device 50 was fixed to the support substrate 53 with a sufficient precision, the large sum facility had been required.

[0006] Therefore, this invention aims at offering the manufacture approach of the piezoelectric transducer which promoted free vibration and stabilized the property by making a support substrate support a piezoelectric device locally and with

high precision in the node of the vibration.

[0007]

[Means for Solving the Problem] This invention is characterized by taking the following solution means, in order to attain the above-mentioned purpose. That is, the 1st invention consists of the process which forms the solder resist which has opening in the supporter of this piezoelectric device in one principal plane of a piezoelectric device in which the electrode was formed, the process which forms a pewter bump at least in opening of said electrode located in said opening of said solder resist, a process which attaches said piezoelectric device in said support substrate by combining said pewter bump with the support electrode of a support substrate, and a process which removes said solder resist.

[0008] This invention forms in the part used as the node of vibration of a piezoelectric device the solder resist which has opening, and a pewter bump is formed in the opening part of a piezoelectric device in which opening of this solder resist is located. Since the supporter which serves as a support part in the node of vibration of a piezoelectric device is combined with the support electrode of a support substrate When pewter PAMPU fuses, the fusion face product can be limited to the magnitude of said opening, and cannot be expanded more than it, but can fix a piezoelectric device to a support substrate restrictively in the proper part of the node of vibration of a piezoelectric device.

[0009] Moreover, in this invention, a solder resist intervenes between a support substrate and a piezoelectric device, and a piezoelectric device is maintained almost horizontally to a support substrate, and a piezoelectric device does not incline in that longitudinal direction or the direction of a short hand, or it does not rotate horizontally. The process at which the 2nd invention forms the solder resist which has two or more openings arranged at equal intervals in one principal plane of the piezo-electric substrate with which the electrode was formed, The process which divides said piezo-electric substrate into two or more piezoelectric devices which have said opening of said solder resist, The process which forms a pewter bump at least in opening of said electrode located in said opening of

said solder resist in said piezoelectric device, and by combining said pewter bump with the support electrode of a support substrate It consists of a process which attaches said piezoelectric device in said support substrate, and a process which removes said solder resist.

[0010] In addition to the operation which the 1st invention has, especially, this invention can form a solder resist in a piezo-electric substrate collectively, can divide a piezo-electric substrate into the piezoelectric device according to individual after that, and can form a pewter bump for every piezoelectric device according to individual.

[0011] The process at which the 3rd invention forms the solder resist which has two or more openings in one principal plane of the piezo-electric substrate with which the electrode was formed, The process which forms a pewter bump at least in opening of said electrode located in said opening of said solder resist in said piezo-electric substrate, It consists of the process which divides said piezo-electric substrate into two or more piezoelectric devices which have said pewter bump, a process which attaches said piezoelectric device in said support substrate by combining said pewter bump of said piezoelectric device with the support electrode of a support substrate, and a process which removes said solder resist.

[0012] In addition to the operation which the 1st invention has, this invention forms the solder resist which has two or more openings in a piezo-electric substrate especially, and after forming a pewter bump at least in this opening, since it divides a piezo-electric substrate into each piezoelectric device, it can form a solder resist and a pewter bump in a piezo-electric substrate collectively.

[0013] The process at which the 4th invention forms the solder resist which has at least one opening in one principal plane of the support substrate with which the electrode was formed, The process which forms a pewter bump at least in opening of said electrode located in said opening of said solder resist in said support substrate, and by combining the supporter of a piezoelectric device with said pewter bump It becomes said support substrate from the process which

attaches said piezoelectric device, and the process which removes said solder resist.

[0014] This invention forms the solder resist which has opening in a support substrate contrary to the 1st invention, forms a pewter bump in this opening, and combines the supporter of the node of a piezoelectric device with this pewter bump. That is, this invention forms a solder resist and a pewter bump in a support substrate to the 1st invention forming a solder resist and a pewter bump in a piezo-electric substrate. However, even if there was this difference, it has the operation described in the 1st invention, and the almost same operation.

[0015] The process at which the 5th invention forms the solder resist which has two or more openings in one principal plane of the piezo-electric substrate with which the electrode was formed, The process which forms a pewter bump at least in opening of said electrode located in said opening of said solder resist in said piezo-electric substrate, By combining said pewter bump of said piezo-electric substrate with this support electrode of an insulating substrate with which two or more support electrodes were formed It consists of the process which attaches said piezo-electric substrate in said insulating substrate, a process which divides the combination of said piezo-electric substrate and insulating substrate into two or more piezoelectric transducers, and a process which removes said solder resist.

[0016] After this invention forms a solder resist and a pewter bump in a piezo-electric substrate especially in addition to the operation which the 1st invention has, without dividing a piezo-electric substrate into a piezoelectric device, it combines with an insulating substrate through a pewter bump, and divides a direct piezo-electricity substrate into two or more piezoelectric transducers after that. Therefore, formation of a solder resist, a pewter bump's formation, a pewter bump's association, and the dicing to a chip (piezoelectric transducer) can be processed collectively.

[0017]

[Embodiment of the Invention] Below, the 1st example of the manufacture

approach of the piezoelectric transducer concerning this invention is explained with reference to drawing 7 from drawing 1 . First, in drawing 1 , 1 is a piezo-electric substrate, for example, consists of piezo electric crystals, such as piezoelectric ceramics, lithium niobate, lithium tantalate, and Xtal. The electrode 2 is formed in both sides of this piezo-electric substrate 1. And this piezo-electric substrate 1 is divided into two or more piezoelectric-device 1a in a back process, as a broken line shows.

[0018] A solder resist 3 is formed in one principal plane of the electrode 2 of the piezo-electric substrate 1 in drawing 2 . This solder resist 3 has opening 3a at least in the supporter which hits the node of crookedness vibration of each piezoelectric-device 1a divided. This opening 3a is formed of for example, a resist mask or photo etching. moreover, the configuration of this opening 3a -- ****, such as circular, an ellipse form, a rectangle, and band-like, -- although a configuration [like] is sufficient, in the piezoelectric transducer for the oscillating gyroscopes of this example, a diameter (width of face) is 0.1-0.2mm. And the diameter (width of face) of this opening 3a restricts the range where the below-mentioned pewter bump fuses and spreads.

[0019] The pewter bump 4 who has about 2 times [of the thickness of a solder resist 3] height is formed in opening part 2a of an electrode 2 located in opening 3a of a solder resist 3 in drawing 4 at drawing 3 and a detail. This pewter bump 4 is formed a little small and highly rather than the magnitude of opening 3a of a solder resist 3. Speaking concretely, a pewter bump's height being 100 micrometers to the thickness of a 20-50-micrometer solder resist. this pewter bump 4 is alike with means of the conventional known, such as the wirebonding method, the pewter ball method, print processes, and dip coating, and is formed. In this case, the pewter bump's 4 volume is the same as the volume of opening 3a, or is formed small slightly. Thus, as a broken line shows, cutting division of the piezo-electric substrate 1 with which the pewter bump 4 was formed is carried out for example, with a dicing machine at two or more piezoelectric-device 1a. In drawing 5 , divided piezoelectric-device 1a makes the pewter bump

4 side counter to the support substrate 5, and is arranged (placing upside down). The support substrate 5 is made for example, from a multilayer substrate, and support electrode 5a is prepared in the front face. Preferably, the solder **** prevention film is prepared in the multilayer substrate front face except a support electrode 5a part, and it is flat-tapped with a support electrode. The support substrate 5 is prepared for each piezoelectric-device 1a of every.

[0020] In drawing 6 , piezoelectric-device 1a is laid on the support substrate 5, and support electrode 5a which formed the pewter bump 4 on the support substrate 5 corresponding to the pewter bump's 4 location is contacted. Then, the front face of a solder resist 3 is contacted on the front face of the support substrate 5, carrying out melting of the pewter bump 4 in an infrared furnace, oven, etc. Consequently, the pewter bump 4 deforms in response to the effect of the configuration of opening 3a of a solder resist 3, and makes it solidify as base material 4a. In case this pewter bump 4 does melting solidification, piezoelectric-device 1a aligns automatically according to that alignment operation in the proper location of the support substrate 5, and it is fixed ****. If support electrode 5a is not extremely small to the pewter bump's 4 diameter, it is good in the configuration and magnitude of arbitration. Moreover, support electrode 5a serves also as the drawer electrode of piezoelectric-device 1a, and is connected to the circuit pattern prepared in the support substrate 5.

[0021] In drawing 7 , it is immersed in a resist exfoliation solvent, and piezoelectric-device 1a fixed to the support substrate 5 exfoliates, and a solder resist 3 is washed. In piezoelectric-device 1a, the pewter bump 4 will be restrictively supported in that node part by base material 4a which carried out melting solidification and deformed, and this base material 4a will give electrical installation to support electrode 5a of reinforcement and the support substrate 5 which supports piezoelectric-device 1a. And from the remaining electrodes 2 of piezoelectric-device 1a, lead-wire r is drawn in the node point of vibration, and a piezoelectric transducer is manufactured.

[0022] Next, the 2nd example of this invention is explained with reference to

drawing 12 from drawing 8 . The place where the 1st example formed this example in the insulating-substrate (support substrate) side to having formed the solder resist and the pewter bump in the piezo-electric substrate (piezoelectric device) side is different from the 1st example.

[0023] First, in drawing 8 , 6 is an insulating substrate and consists of a resin substrate, a ceramic substrate, etc. The electrode 7 is formed all over one principal plane of this insulating substrate 6. And a solder resist 3 is formed on this electrode 7. Although this solder resist 3 is divided into two or more support substrate 6a as an insulating substrate 6 shows a back process with a broken line, it has every two opening 3a in the longitudinal direction of each of this support substrate 6a divided. Properties, such as magnitude of this opening 3a, the operation, the function, etc. are the same as that of the place explained in the 1st example.

[0024] Next, the pewter bump 4 is formed in opening part 7a (it is equivalent to opening part 2a in drawing 4) of an electrode 7 located in opening 3a of a solder resist 3 in drawing 9 . This pewter bump's 4 property, the operation, the function, etc. are the same as explanation of the 1st example. Thus, as a broken line shows, cutting division of the insulating substrate 6 in which the pewter bump 4 was formed is carried out at two or more support substrate 6a.

[0025] In drawing 10 , on it, the pewter bump 4 side is turned up and it is arranged, and piezoelectric-device 1a by which the electrode 2 was formed in both sides makes the node n shown with a broken line correspond to the pewter bump 4, and divided support substrate 6a makes and is arranged. In addition, this drawing 10 ****s in drawing 5 in the 1st example. Moreover, each piezoelectric-device 1a is formed by cutting the piezo-electric substrate 1 shown in drawing 1 .

[0026] In drawing 11 , piezoelectric-device 1a is laid on support substrate 6a, the pewter bump 4 is contacted in the node n part of 1a of a piezoelectric device, melting solidification of this pewter bump 4 is carried out, and base material 4a is formed. Piezoelectric-device 1a will be restrictively supported in the node part of

the vibration like the 1st example by base material 4a which the pewter bump 4 did melting solidification and deformed. In addition, this drawing 11 ****s in drawing 6 in the 1st example. In this case, there is no self-alignment operation by the pewter bump's 4 melting.

[0027] In drawing 12 , it is immersed in a resist exfoliation solvent, and support substrate 6a and piezoelectric-device 1a which were fixed to one through base material 4a exfoliate, and a solder resist 3 is washed. Lead-wire r is given to the remaining electrodes of piezoelectric-device 1a, and the electrode 7 of support substrate 6a, respectively, and it becomes a piezoelectric transducer.

[0028] In addition, in an oscillating gyroscope etc., hyperfractionation of the electrode 2 of the support substrate 6a and the opposite side which are shown in this drawing is carried out, and the piezoelectric transducer shown in drawing 12 manufactured in the piezoelectric transducer and the 2nd example which are shown in drawing 7 manufactured in the 1st example is used as the electrode for a drive, and an electrode for detection of Coriolis force vibration, although it is the thing of 2 electrode structures.

[0029] In the 1st example, after forming a solder resist 3 and the pewter bump 4 in the piezo-electric substrate 1, this piezo-electric substrate 1 was cut, but after forming a solder resist 3 in the piezo-electric substrate 1, it may cut to piezoelectric-device 1a, and the pewter bump 4 may be formed in this piezoelectric-device 1a after that.

[0030] Moreover, in the 2nd example, after forming a solder resist 3 and the pewter bump 4 in an insulating substrate 6, this insulating substrate 6 was cut, but after cutting the insulating substrate 6 in which the solder resist 3 was formed to support substrate 6a, the pewter bump 4 may be formed in this support substrate 6a.

[0031] In each above-mentioned example, although the piezo-electric substrate 1 and piezoelectric-device 1a showed the thing of veneer structure, the thing of bimorph structure or multilayer structure is sufficient as them.

[0032] Although association by the pewter bump 4 of piezoelectric-device 1a and

support substrate 5a was performed after cutting the piezo-electric substrate 1 or insulating substrate 6 in which the pewter bump 4 was formed to piezoelectric-device 1a or support substrate 5a in each above-mentioned example, respectively After combining the piezo-electric substrate 1 and insulating substrate 6 by which the solder resist 3 and the pewter bump 4 were formed in either through the pewter bump 4, carry out the dicing of the combination of the piezo-electric substrate 1 and an insulating substrate 6, and it separates into a chip (piezoelectric transducer). A solder resist 3 may be removed for every chip.

[0033] In the above-mentioned example, it has two nodes, and although the piezoelectric transducer of the simple beam structure which supports these two nodes, respectively was explained, this invention is applicable also to the piezoelectric transducer of the cantilever structure which supports one node.

[0034]

[Effect of the Invention] This invention forms the solder resist which has opening in a piezoelectric device (piezo-electric substrate) or a support substrate (insulating substrate). A piezoelectric device is fixed to a support substrate by the base material which formed the pewter bump through this opening and was formed of this pewter bump's melting hardening. Since it is dependent on the configuration of opening, and magnitude, the configuration of this base material and magnitude can form the base material of an arbitration configuration in the proper location of an oscillating node restrictively and with high precision, and can manufacture the piezoelectric transducer with which free vibration is not oppressed and to which the property was equal.

[0035] Moreover, since a solder resist has the operation which maintains a piezoelectric transducer horizontally to a support substrate when a pewter bump fuses, it combines with the self alignment at the time of pewter melting (self-alignment operation), and a piezoelectric transducer does not have an inclination and is fixed proper.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Process drawing which forms an electrode in a piezo-electric substrate in the 1st example of the manufacture approach of the piezoelectric transducer concerning this invention
[Drawing 2] Process drawing which forms the solder resist which has two or more openings in a piezo-electric substrate
[Drawing 3] Process drawing which forms a pewter bump in a piezo-electric substrate through opening of a solder resist
[Drawing 4] The expanded sectional view of opening of a solder resist shown in drawing 3
[Drawing 5] Process drawing which arranges a piezoelectric device to a support substrate
[Drawing 6] Process drawing which carries out joint immobilization of a support substrate and the piezoelectric device by the pewter bump
[Drawing 7] Process drawing from which a solder resist is removed
[Drawing 8] Process drawing which forms the solder resist which has two or more openings in an insulating substrate in the 2nd example of the manufacture approach of the piezoelectric transducer concerning this invention
[Drawing 9] Process drawing which forms a pewter bump in an insulating

substrate through opening of a solder resist

[Drawing 10] Process drawing which arranges a piezoelectric device to a support substrate

[Drawing 11] Process drawing which carries out joint immobilization of a support substrate and the piezoelectric device by the pewter bump

[Drawing 12] Process drawing from which a solder resist is removed

[Drawing 13] Process drawing which arranges the piezoelectric device which applied the pewter paste as a base material to the support substrate in the manufacture approach of the conventional piezoelectric transducer

[Drawing 14] Process drawing which carries out joint immobilization of a support substrate and the piezoelectric device with a pewter paste in the manufacture approach of the conventional piezoelectric transducer

[Drawing 15] Drawing showing the inclination to the longitudinal direction of the piezoelectric transducer manufactured in the conventional manufacture approach

[Drawing 16] Drawing showing the inclination to the longitudinal direction of the piezoelectric transducer manufactured in the conventional manufacture approach

[Drawing 17] Drawing showing the rotation to the direction of a flat surface of the piezoelectric transducer manufactured in the conventional manufacture approach

[Description of Notations]

1 Piezo-electric Substrate

1a Piezoelectric device

2 Seven Electrode

2a, 7a Opening part

3 Solder Resist

3a Opening

4 Pewter Bump

4a Base material

5 Support Substrate

5a Support electrode

6 Insulating Substrate

6a Support substrate

r Lead wire

[Translation done.]

* NOTICES *

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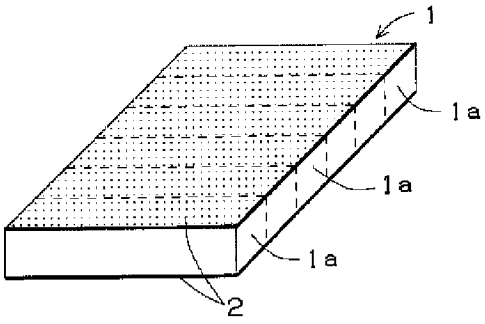
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

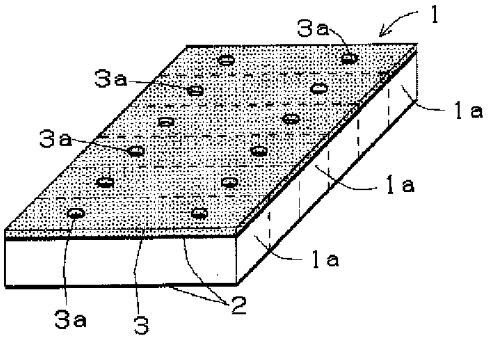
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



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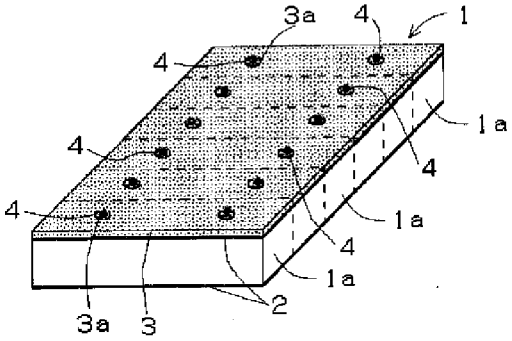

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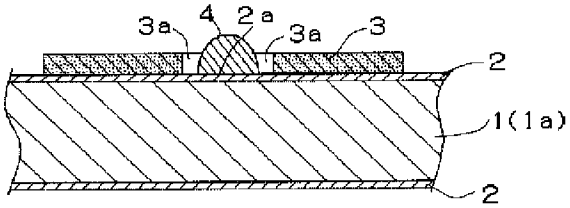

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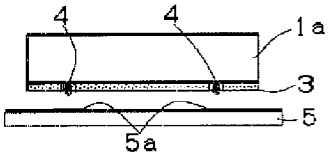
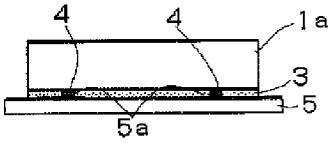


[Drawing 6]



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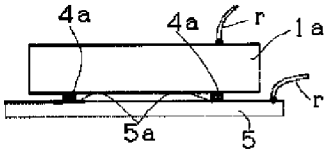

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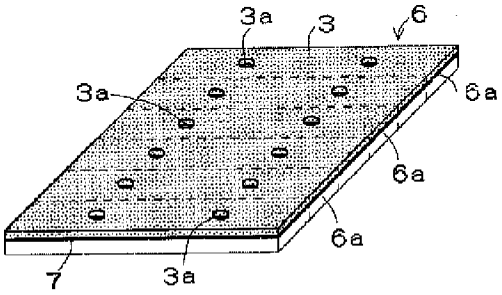

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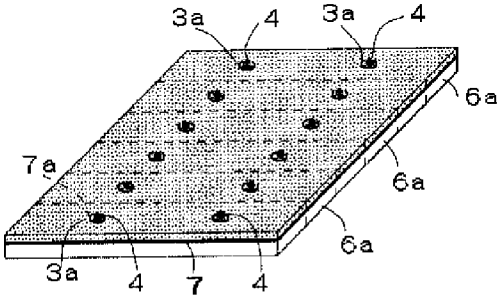
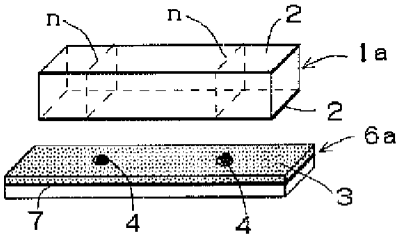
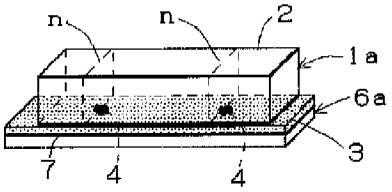


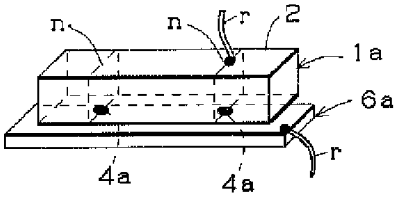
[Drawing 10]



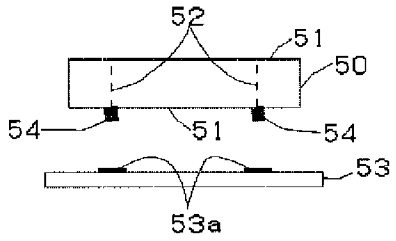
[Drawing 11]



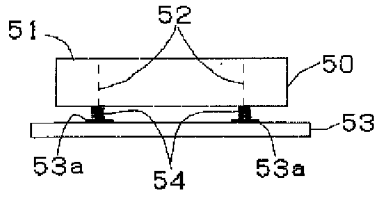
[Drawing 12]



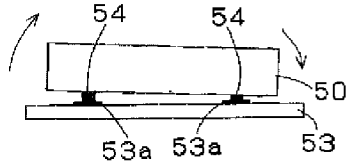
[Drawing 13]



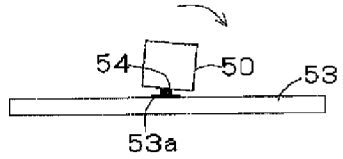
[Drawing 14]



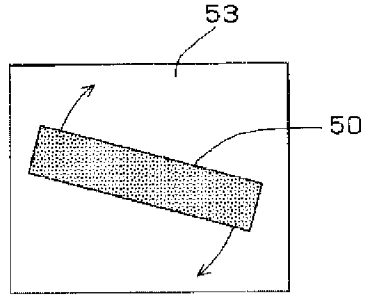
[Drawing 15]



[Drawing 16]



[Drawing 17]



[Translation done.]

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Ｇ０１Ｐ　9/04			Ｇ０１Ｐ　9/04	
15/08			15/08	

審査請求　未請求　請求項の数５　ＯＬ　（全　７　頁）

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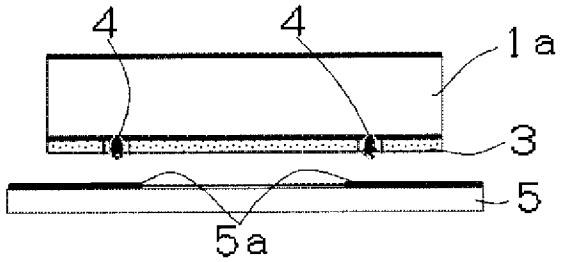
(54)【発明の名称】　圧電振動子の製造方法

(57)【要約】
【課題】圧電素子をその振動のノードにおいて支持基板に限定的かつ高精度に支持させることのできる支持体をハンダバンプにより形成することにより、自由振動を助長して特性を安定させた圧電振動子の製造方法を提供することである。
【解決手段】電極２の形成された圧電素子１ａの一つの主面に、この圧電素子１ａの支持部に開口３ａを有するソルダーレジスト３を形成する工程と、圧電素子１ａにおけるソルダーレジスト３の開口３ａに位置する電極２の開口部位にハンダバンプ４を形成する工程と、支持基板５の支持電極５ａにハンダバンプ４を結合することにより、圧電素子１ａを支持基板５に取り付ける工程と、ソルダーレジスト３を除去する工程とを用いて圧電振動子を製造する。



【特許請求の範囲】
【請求項１】　電極の形成された圧電素子の一つの主面に、この圧電素子の支持部に開口部を有するソルダーレジストを形成する工程と、
前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、
支持基板の支持電極に前記ハンダバンプを結合することにより、前記圧電素子を前記支持基板に取り付ける工程と、
前記ソルダーレジストを除去する工程と、
よりなる圧電振動子の製造方法。
【請求項２】　電極の形成された圧電基板の一つの主面に、等間隔に配列された複数個の開口部を有するソルダーレジストを形成する工程と、
前記圧電基板を前記ソルダーレジストの前記開口部を有する複数個の圧電素子に分割する工程と、
前記圧電素子における前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、
支持基板の支持電極に前記ハンダバンプを結合することにより、前記圧電素子を前記支持基板に取り付ける工程と、
前記ソルダーレジストを除去する工程と、
よりなる圧電振動子の製造方法。
【請求項３】　電極の形成された圧電基板の一つの主面に、等間隔に配列された複数個の開口部を有するソルダーレジストを形成する工程と、
前記圧電基板における前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、
前記圧電基板を前記ハンダバンプを有する複数個の圧電素子に分割する工程と、
支持基板の支持電極に前記圧電素子の前記ハンダバンプを結合することにより、前記圧電素子を前記支持基板に取り付ける工程と、
前記ソルダーレジストを除去する工程と、
よりなる圧電振動子の製造方法。
【請求項４】　電極の形成された支持基板の一つの主面に、少なくとも一つの開口部を有するソルダーレジストを形成する工程と、
前記支持基板における前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、
前記ハンダバンプに圧電素子の支持部を結合することにより、前記支持基板に前記圧電素子を取り付ける工程と、
前記ソルダーレジストを除去する工程と、
よりなる圧電振動子の製造方法。
【請求項５】　電極の形成された圧電基板の一つの主面に、複数個の開口部を有するソルダーレジストを形成する工程と、
前記圧電基板における前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、
複数個の支持電極が形成された絶縁基板の該支持電極に前記圧電基板の前記ハンダバンプを結合することにより、前記圧電基板を前記絶縁基板に取り付ける工程と、
前記圧電基板と絶縁基板の結合体を複数個の圧電振動子に分割する工程と、
前記ソルダーレジストを除去する工程と、
よりなる圧電振動子の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、振動ジャイロ、発振子、共振子、フィルタなどに使用される圧電振動子の製造方法に関する。
【０００２】
【従来の技術】従来の圧電振動子の製造方法について図１３から図１７を参照して説明する。まず、図１３において、５０は直方体状の圧電素子で、その対向する両面には電極５１がそれぞれ形成されている。この圧電素子５０は、いろいろの振動モードを有しているが、そのうち屈曲振動モードのノード５２が破線で示す部位となる。一方、５３は支持基板である。圧電素子５０を支持基板５３に取り付けるに際しては、圧電素子５０の屈曲振動を抑圧しないように、圧電素子５０のノード５２で支持する必要がある。
【０００３】この支持体の製造方法として、従来、ディスペンサ若しくは印刷機により、導電性若しくはハンダペースト５４を圧電素子５０のノード５２の部位に塗布し、このペースト５４の塗布された圧電素子５０を、図１４に示すように、支持基板５３上に載置して、支持基板５３に形成された支持電極５３ａ上にペースト５４を当接する。そして、適宜の押圧力を圧電素子５０に加えて、ペースト５４を硬化もしくは溶融固化させて、支持基板５３に圧電素子５０を固定させていた。
【０００４】
【発明が解決しようとする課題】しかしながら、従来の圧電振動子の製造方法においては、ディスペンサ若しくは印刷機によりペースト５４を塗布しているので、経時的かつ連続作業において、ペースト５４の粘度変化または作業環境の変化により、塗布量がばらつき、塗布面積が変化していた。そのため、圧電素子５０がそのノード５２の適正部位で支持されず、圧電振動子の特性がばらついていた。したがって、塗布量を一定に保持するために、ペースト５４の粘度や温度などの作業環境を一定に管理する必要があり、作業の効率低下を招いていた。
【０００５】また、ペースト５５が溶融した際に、図１５に示すように、圧電素子５０が支持基板５３に対し、長手方向に傾斜して固定されたり、また、図１６に示す

ように、短手方向に傾斜して固定されたり、また図１７に示すように、水平方向に回動して固定されるという問題があった。特に、振動ジャイロ用の圧電素子５０の場合には、支持基板５３に対する圧電素子５０の固定角度および傾き精度が重要であり、この圧電素子５０を精度よく支持基板５３に固定するために高額な設備を要していた。

【０００６】したがって、本発明は、圧電素子をその振動のノードにおいて支持基板に局部的かつ高精度に支持させることにより、自由振動を助長して特性を安定させた圧電振動子の製造方法を提供することを目的とする。

【０００７】

【課題を解決するための手段】本発明は、上記目的を達成するために、下記の解決手段を採ることを特徴とする。即ち、第１の発明は、電極の形成された圧電素子の一つの主面に、この圧電素子の支持部に開口部を有するソルダーレジストを形成する工程と、前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、支持基板の支持電極に前記ハンダバンプを結合することにより、前記圧電素子を前記支持基板に取り付ける工程と、前記ソルダーレジストを除去する工程とよりなる。

【０００８】この発明は、圧電素子の振動のノードとなる部位に開口を有するソルダーレジストを形成し、このソルダーレジストの開口の位置する圧電素子の開口部位にハンダバンプを形成して、圧電素子の振動のノードにおいて支持箇所となる支持部を支持基板の支持電極に結合するので、ハンダバンプが溶融したとき、その溶融面積が前記開口の大きさに限定されて、それ以上に拡大せず、圧電素子の振動のノードの適正部位において限定的に圧電素子を支持基板に固定することができる。

【０００９】また、この発明においては、ソルダーレジストが支持基板と圧電素子との間に介在して、圧電素子が支持基板に対しほぼ水平に維持されて、圧電素子がその長手方向もしくは短手方向に傾斜したり、または水平方向に回動することがない。第２の発明は、電極の形成された圧電基板の一つの主面に、等間隔に配列された複数個の開口部を有するソルダーレジストを形成する工程と、前記圧電基板を前記ソルダーレジストの前記開口部を有する複数個の圧電素子に分割する工程と、前記圧電素子における前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、支持基板の支持電極に前記ハンダバンプを結合することにより、前記圧電素子を前記支持基板に取り付ける工程と、前記ソルダーレジストを除去する工程とよりなる。

【００１０】この発明は、第１の発明の有する作用に加えるに、特に、圧電基板にソルダーレジストを一括して形成し、その後圧電基板を個別の圧電素子に分割して、個別の圧電素子ごとにハンダバンプを形成することができる。

【００１１】第３の発明は、電極の形成された圧電基板の一つの主面に、複数個の開口部を有するソルダーレジストを形成する工程と、前記圧電基板における前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、前記圧電基板を前記ハンダバンプを有する複数個の圧電素子に分割する工程と、支持基板の支持電極に前記圧電素子の前記ハンダバンプを結合することにより、前記圧電素子を前記支持基板に取り付ける工程と、前記ソルダーレジストを除去する工程とよりなる。

【００１２】この発明は、第１の発明の有する作用に加えるに、特に、圧電基板に複数個の開口部を有するソルダーレジストを形成し、そしてこの開口部位にハンダバンプを形成した後、圧電基板を各圧電素子に分割するので、圧電基板にソルダーレジストとハンダバンプを一括して形成できる。

【００１３】第４の発明は、電極の形成された支持基板の一つの主面に、少なくとも一つの開口部を有するソルダーレジストを形成する工程と、前記支持基板における前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、前記ハンダバンプに圧電素子の支持部を結合することにより、前記支持基板に前記圧電素子を取り付ける工程と、前記ソルダーレジストを除去する工程とよりなる。

【００１４】この発明は、第１の発明とは反対に、支持基板に開口部を有するソルダーレジストを形成し、この開口部にハンダバンプを形成して、このハンダバンプに圧電素子のノードの支持部を結合する。即ち、第１の発明が、圧電基板にソルダーレジストとハンダバンプを形成するのに対して、この発明は、支持基板にソルダーレジストとハンダバンプを形成する。しかしながら、この相違があったにしても、第１の発明において記述した作用とほぼ同様の作用を有している。

【００１５】第５の発明は、電極の形成された圧電基板の一つの主面に、複数個の開口部を有するソルダーレジストを形成する工程と、前記圧電基板における前記ソルダーレジストの前記開口部に位置する前記電極の開口部位にハンダバンプを形成する工程と、複数個の支持電極が形成された絶縁基板の該支持電極に前記圧電基板の前記ハンダバンプを結合することにより、前記圧電基板を前記絶縁基板に取り付ける工程と、前記圧電基板と絶縁基板の結合体を複数個の圧電振動子に分割する工程と、前記ソルダーレジストを除去する工程とよりなる。

【００１６】この発明は、第１の発明の有する作用に加えるに、特に、圧電基板にソルダーレジストとハンダバンプを形成した後、圧電基板を圧電素子に分割せずに、直接圧電基板を絶縁基板にハンダバンプを介して結合し、その後、複数個の圧電振動子に分割する。したがって、ソルダーレジストの形成、ハンダバンプの形成、ハ

ンダバンプの結合、およびチップ（圧電振動子）へのダイシングを一括して処理できることになる。

【００１７】

【発明の実施の形態】以下に、本発明に係る圧電振動子の製造方法の第１実施例について図１から図７を参照して説明する。まず、図１において、１は圧電基板で、例えば、圧電性のセラミックス、ニオブ酸リチウム、タンタル酸リチウム、水晶などの圧電体よりなる。この圧電基板１の両面には、電極２が形成されている。そして、この圧電基板１は、破線で示すように、後工程において、複数個の圧電素子１ａに分割される。

【００１８】図２において、圧電基板１の電極２の一つの主面には、ソルダーレジスト３が形成される。このソルダーレジスト３は、分割される各圧電素子１ａの屈曲振動のノードに当たる支持部位に、開口３ａを有している。この開口３ａは、例えば、レジストマスク、あるいはフォトエッチングなどにより形成される。また、この開口３ａの形状は、円形、楕円形、矩形、帯状などいかような形状でもよいが、本実施例の振動ジャイロ用の圧電振動子においては、直径（幅）が例えば、０．１～０．２ｍｍである。そして、この開口３ａの直径（幅）は、後述のハンダバンプが溶融して広がる範囲を制限するものである。

【００１９】図３および詳細には図４において、ソルダーレジスト３の開口３ａに位置する電極２の開口部位２ａには、例えば、ソルダーレジスト３の厚みの２倍程度の高さを有するハンダバンプ４が形成される。このハンダバンプ４は、ソルダーレジスト３の開口３ａの大きさよりもやや小さく且つ高く形成される。具体的に言うと、２０～５０μｍのソルダーレジストの厚みに対してハンダバンプの高さは１００μｍである。このハンダバンプ４は、ワイヤボンディング法、ハンダボール法、印刷法、浸漬法など従来既知の手段によりに形成される。この場合、ハンダバンプ４の体積は、開口部３ａの容積と同じか、または僅かに小さく形成される。このように、ハンダバンプ４の形成された圧電基板１は、破線で示すように、複数個の圧電素子１ａに、例えば、ダイシングマシーンにより切断分割される。図５において、分割された圧電素子１ａは支持基板５に対してハンダバンプ４側を対向させて（下向きにして）配置される。支持基板５は、例えば、多層基板から作られ、その表面には、支持電極５ａが設けられている。好ましくは、支持電極５ａ部分を除く多層基板表面には、はんだ濡れ防止膜が設けられ、支持電極と面一になっている。支持基板５は各圧電素子１ａごとに用意されている。

【００２０】図６において、支持基板５上に圧電素子１ａを載置し、ハンダバンプ４を支持基板５の上にハンダバンプ４の位置に対応して設けた支持電極５ａに当接する。その後、赤外線炉、オーブンなどによりハンダバンプ４を溶融させながら、ソルダーレジスト３の表面を支持基板５の表面に接触させる。この結果、ハンダバンプ４は、ソルダーレジスト３の開口３ａの形状の影響を受けて変形し、支持体４ａとして固化させる。このハンダバンプ４が溶融固化する際、その整列作用により圧電素子１ａは自動的に支持基板５の適正位置に整列して固定さる。支持電極５ａは、ハンダバンプ４の直径に対して極端に小さくなければ任意の形状および大きさでよい。また、支持電極５ａは、圧電素子１ａの引出電極も兼ねており、支持基板５に設けた配線パターンに接続されている。

【００２１】図７において、支持基板５に固定された圧電素子１ａは、レジスト剥離溶剤に浸漬されてソルダーレジスト３を剥離され、洗浄される。圧電素子１ａは、ハンダバンプ４が溶融固化して変形した支持体４ａにより、そのノード部位を限定的に支持され、この支持体４ａは圧電素子１ａを支持する強度と支持基板５の支持電極５ａに電気的接続を与えることになる。そして、圧電素子１ａの残りの電極２からは、振動のノード点においてリード線ｒが導出されて、圧電振動子が製造される。

【００２２】次に、本発明の第２実施例について図８から図１２を参照して説明する。本実施例は、第１実施例がソルダーレジストおよびハンダバンプを圧電基板（圧電素子）側に形成したのに対し、絶縁基板（支持基板）側に形成したところが第１実施例と相違する。

【００２３】まず、図８において、６は絶縁基板で、樹脂基板、セラミックス基板などよりなる。この絶縁基板６の一つの主面の全面には電極７が形成されている。そして、この電極７の上には、ソルダーレジスト３が形成される。このソルダーレジスト３は、後工程において絶縁基板６が破線で示すように、複数個の支持基板６ａに分割されるが、この分割される各支持基板６ａの長手方向に２個ずつの開口３ａを有している。この開口３ａの大きさなどの性質、作用、機能などは第１実施例において説明したところと同様である。

【００２４】つぎに、図９において、ソルダーレジスト３の開口３ａに位置する電極７の開口部位７ａ（図４における開口部位２ａに相当する）には、ハンダバンプ４が形成される。このハンダバンプ４の性質、作用、機能などは第１実施例の説明と同様である。このように、ハンダバンプ４の形成された絶縁基板６は、破線で示すように、複数個の支持基板６ａに切断分割される。

【００２５】図１０において、分割された支持基板６ａは、ハンダバンプ４側を上にして配置され、且つ、その上には、両面に電極２の形成された圧電素子１ａが破線で示すノードｎをハンダバンプ４に対応させるようにして配置される。なお、この図１０は第１実施例における図５に相応する。また、各圧電素子１ａは、図１に示す圧電基板１を切断することにより形成されている。

【００２６】図１１において、支持基板６ａ上に圧電素子１ａを載置して、ハンダバンプ４に圧電素子の１ａの

ノードｎ部位を当接し、このハンダバンプ４を溶融固化させて、支持体４ａを形成する。圧電素子１ａは、第１実施例と同様に、ハンダバンプ４が溶融固化して変形した支持体４ａにより、その振動のノード部位を限定的に支持されることになる。なお、この図１１は第１実施例における図６に相応する。この場合、ハンダバンプ４の溶融による自己整列作用はない。

【００２７】図１２において、支持体４ａを介して一体に固定された支持基板６ａと圧電素子１ａは、レジスト剥離溶剤に浸漬されてソルダーレジスト３を剥離され、洗浄される。圧電素子１ａの残りの電極と支持基板６ａの電極７にはそれぞれリード線ｒが付与されて圧電振動子となる。

【００２８】なお、第１実施例において製造された図７に示す圧電振動子および第２実施例において製造された図１２に示す圧電振動子は、２電極構造のものであるが、振動ジャイロスコープなどにおいては、同図に示す支持基板６ａと反対側の電極２が多分割されて駆動用電極とコリオリ力振動の検出用電極として使用される。

【００２９】第１実施例においては、圧電基板１にソルダーレジスト３およびハンダバンプ４を形成した後、この圧電基板１を切断したが、圧電基板１にソルダーレジスト３を形成した後、圧電素子１ａに切断し、その後、この圧電素子１ａにハンダバンプ４を形成してもよい。

【００３０】また、第２実施例においては、絶縁基板６にソルダーレジスト３およびハンダバンプ４を形成した後、この絶縁基板６を切断したが、ソルダーレジスト３の形成された絶縁基板６を支持基板６ａに切断した後、この支持基板６ａにハンダバンプ４を形成してもよい。

【００３１】上記各実施例においては、圧電基板１および圧電素子１ａは、単板構造のものを示したが、バイモルフ構造あるいは多層構造のものでもよい。

【００３２】上記各実施例においては、ハンダバンプ４の形成された圧電基板１または絶縁基板６を圧電素子１ａまたは支持基板５ａにそれぞれ切断した後、圧電素子１ａと支持基板５ａとのハンダバンプ４による結合を行ったが、ソルダーレジスト３とハンダバンプ４がいずれかに形成された圧電基板１と絶縁基板６とを、ハンダバンプ４を介して結合した後、圧電基板１と絶縁基板６の結合体をダイシングしてチップ（圧電振動子）に分離して、各チップ毎にソルダーレジスト３を除去してもよい。

【００３３】上記実施例においては、ノードを二つ有し、この二つのノードをそれぞれ支持する両持梁構造の圧電振動子について説明したが、本発明は、一つのノードを支持する片持梁構造の圧電振動子にも適用できる。

【００３４】

【発明の効果】本発明は、圧電素子（圧電基板）または支持基板（絶縁基板）に開口を有するソルダーレジストを形成する。この開口を通してハンダバンプを形成し、このハンダバンプの溶融硬化により形成された支持体により圧電素子は、支持基板に固定される。この支持体の形状、大きさは、開口の形状、大きさに依存しているので、振動ノードの適正位置に限定的かつ高精度に任意形状の支持体を形成し、自由振動の抑圧されない、特性の揃った圧電振動子を製造することができる。

【００３５】また、ソルダーレジストは、ハンダバンプが溶融したとき、圧電振動子を支持基板に対して水平方向に維持する作用があるので、ハンダ溶融時のセルフアライメント（自己整列作用）と併せて、圧電振動子は、傾きなく、適正に固定される。

【図面の簡単な説明】

【図１】　本発明に係る圧電振動子の製造方法の第１実施例において、圧電基板に電極を形成する工程図

【図２】　圧電基板に複数個の開口を有するソルダーレジストを形成する工程図

【図３】　ソルダーレジストの開口を介して圧電基板にハンダバンプを形成する工程図

【図４】　図３に示すソルダーレジストの開口部の拡大断面図

【図５】　支持基板に対し圧電素子を配置する工程図

【図６】　支持基板と圧電素子とをハンダバンプにより結合固定する工程図

【図７】　ソルダーレジストを除去する工程図

【図８】　本発明に係る圧電振動子の製造方法の第２実施例において、絶縁基板に複数個の開口を有するソルダーレジストを形成する工程図

【図９】　ソルダーレジストの開口を介して絶縁基板にハンダバンプを形成する工程図

【図１０】　支持基板に対し圧電素子を配置する工程図

【図１１】　支持基板と圧電素子とをハンダバンプにより結合固定する工程図

【図１２】　ソルダーレジストを除去する工程図

【図１３】　従来の圧電振動子の製造方法において、支持基板に対して支持体としてハンダペーストを塗布した圧電素子を配置する工程図

【図１４】　従来の圧電振動子の製造方法において、支持基板と圧電素子とをハンダペーストにより結合固定する工程図

【図１５】　従来の製造方法において製造された圧電振動子の長手方向への傾斜を示す図

【図１６】　従来の製造方法において製造された圧電振動子の横方向への傾斜を示す図

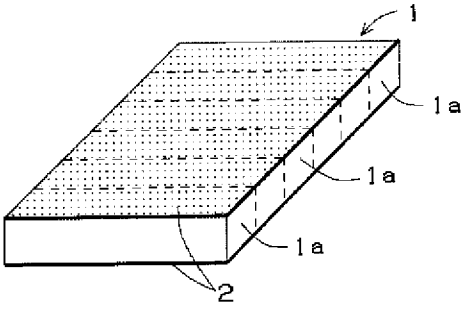
【図１７】　従来の製造方法において製造された圧電振動子の平面方向への回動を示す図

【符号の説明】

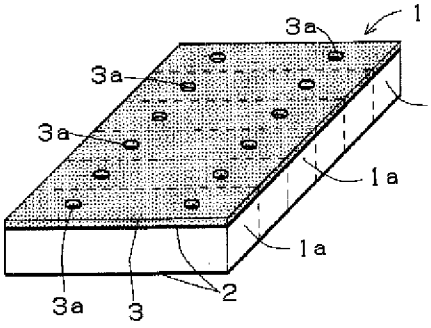
１	圧電基板
１ａ	圧電素子
２、７	電極
２ａ、７ａ	開口部位

３	ソルダーレジスト	５ａ	支持電極
３ａ	開口	６	絶縁基板
４	ハンダバンプ	６ａ	支持基板
４ａ	支持体	ｒ	リード線
５	支持基板		

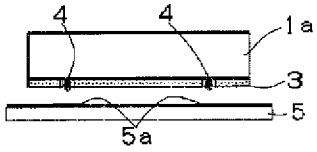
【図１】



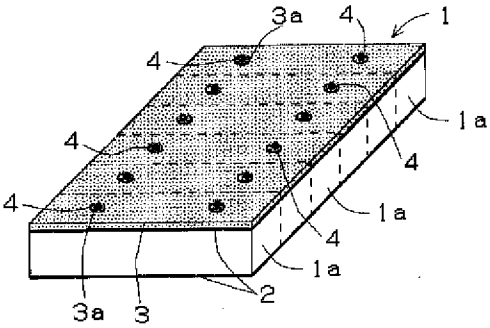
【図２】



【図５】



【図３】



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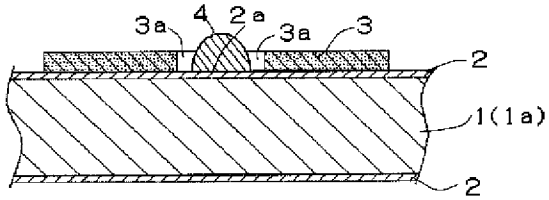
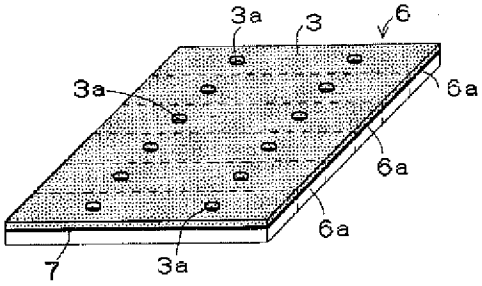


【図８】



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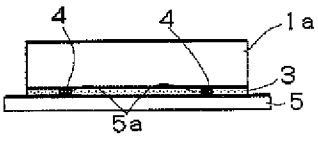
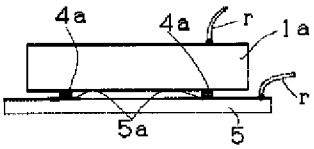


【図７】



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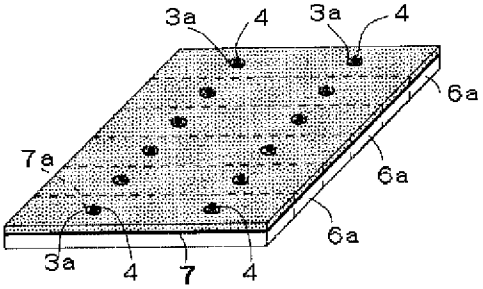
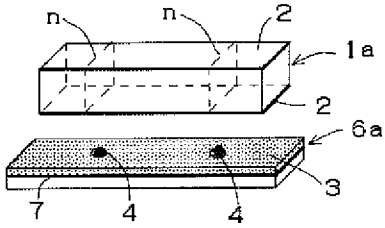
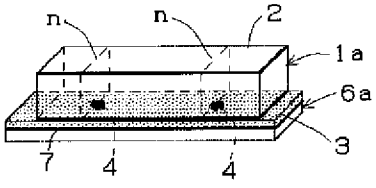


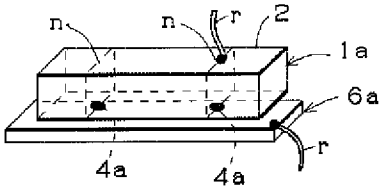
【図１０】



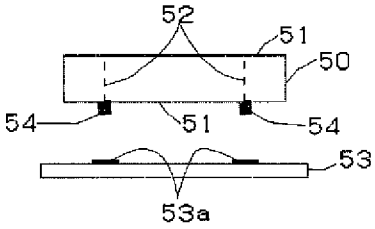
【図１１】



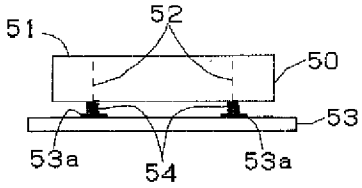
【図１２】



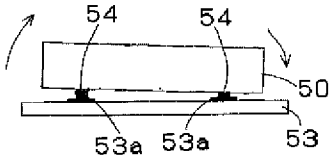
【図１３】



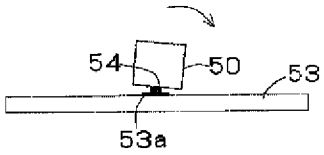
【図１４】



【図１５】



【図１６】



【図１７】